DOCUMENT RESUME

ED 418 848 SE 061 299

AUTHOR	Duggan-Haas, Don
TITLE	Two Programs, Two Cultures: The Dichotomy of Science Teacher Preparation.
PUB DATE	1998-04-00
NOTE	17p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).
PUB TYPE	Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Classroom Environment; *College Science; Educational Change; Educational Objectives; Elementary Secondary Education; Ethnography; Higher Education; *Preservice Teacher Education; Science Education; *Science Teachers; Scientific Attitudes; *Scientists; *Teacher Student Relationship
IDENTIFIERS	*Culture of Science; Meritocracy

ABSTRACT

This paper illustrates the rivalry and dichotomy between science and teacher education programs by describing and contrasting the nature of the two cultures. The two cultures are portrayed through a series of three contrasts: (1) "Weeding Out" vs. nurturing; (2) meritocratic vs. democratic; and (3) masculine vs. feminine. Two studies describing several universities' science programs are referenced extensively for the contrasts. These include the Salish Project which researched the relationship of teacher education programs and the way new science teachers teach, and a study on why science, mathematics, and engineering undergraduate majors change majors at a higher rate than most other undergraduate majors. Both studies describe college science classrooms as places where students are lectured to, competition is fostered, and collaboration is discouraged. Little support from faculty is available or encouraged, and students in introductory science classes are discouraged from continuing science coursework through several selection techniques. In teacher education, however, instructors generally attempt to foster a classroom community by requiring collaboration and discouraging competition. Instructors encourage success for everyone. Both cultures were found to work on, at least, some level. This paper explores ways to reconcile the two cultures and improve college science teaching to reduce attrition. Contains 21 references. (PVD)

Two Programs, Two Cultures: The Dichotomy of Science Teacher Preparation

by
Don Duggan-Haas

Two Programs, Two Cultures:
The Dichotomy of Science Teacher Preparation

Introduction

As science teacher candidates move through their teacher preparation programs, they move between the meritocratic, masculine culture of their science classrooms and the democratic, feminine culture of their teacher education classrooms. Both cultures attempt to win the allegiance of the teacher candidate. Furthermore, the keepers of the culture of the college science classroom intentionally distance themselves from education in general and teacher preparation programs in particular. This paper describes the rivalry between science and teacher education by describing and contrasting the nature of the two cultures.

C. P. Snow's timeless work, *Two Cultures and the Scientific Revolution* (1959) inspired the framework I employ in this paper. In *Two Cultures,* Snow described the growing rift between the academic cultures of science and of the humanities. Such a framework suits the cultures of the college science *classroom* and the college teacher education classroom. It is important that I stress neither of the cultures I refer to are the same, or even particularly similar too, the cultures that Snow wrote about. He addressed how academics work and speak with <u>each other</u>. I am addressing how academics work with and speak to <u>their students</u>.

I will portray these two cultures through a series of three contrasts between the culture of the science classroom and that of the teacher education classroom: ① "Weeding out" vs. Nurturing; ② Meritocratic vs. Democratic; and ③ Masculine vs. Feminine. These three contrasts are obviously overlapping; the first two contrasts, in fact, combine to make the third. I will also draw conclusions on the impacts the dichotomy has on the preparation of science teachers and discuss differences in the levels of risk and ambiguity of the two classroom cultures. Before laying out the contrasts, I will give a very brief overview of my own background which may be useful in understanding this paper, followed by a brief introduction to each culture.

I am an advanced graduate student in teacher education and have worked on the Salish I Research Project researching the relationship of teacher education programs and the way new science teachers teach. Prior to entering graduate school, I taught high school Earth science and physics for eight years. I began my undergraduate work as a dual major in physics and engineering. Halfway through that program, I changed to a straight physics major with a minor in education. The descriptions and contrasts that follow use my background in teaching and teacher education as a lens to focus on college science teaching.

I have adapted C. P. Snow's framework of two cultures (Snow, 1959) to describe the largest portions of science teacher candidates' college classroom experiences. There are of course, more than two cultures. I have discussed this previously (Duggan-Haas, 1997) but will very briefly revisit it here. Field biologists speak and work very differently from theoretical physicists in their research, but, what they do in the classrooms where they teach, is remarkably similar to each other and remarkably different from what is going on in teacher education classrooms on the same campus. Teacher educators behave like teacher educators. Scientists who lecture act like scientists who lecture. Within each set of classrooms (that is, within each culture), "...without thinking about it, they respond alike. That is what culture means." (Snow, 1959, p.11)

In comparisons across several universities, striking similarities are found in the way science is taught. Two studies, each describing several universities' science programs will be referenced extensively. The Salish Project, involved nine universities and their recent

Paper presented at the American Educational Research Association Annual Conference, April 1998, San Diego, CA.

The author welcomes comments on this paper. Contact Don Duggan-Haas at 301D Erickson Hall, Michigan State University, East Lansing, MI 48824; (517) 355-1725 or via e-mail at <haasdona@pilot.msu.edu>.

graduates in science education[1]. The second study referenced is Elaine Seymour's and Nancy Hewitt's study of why science, mathematics and engineering (S.M.E) undergraduate majors change majors at a higher rate than most other undergraduate majors.

Seymour and Hewitt's book, *Talking About Leaving: Why Undergraduates Leave the Sciences* chronicles their ethnographic study of 335 undergraduate students who switched from S.M.E programs as well as students who stayed in S.M.E programs at seven colleges and universities. The study design included slightly more switchers (54.6%) than non-switchers (45.4%) and women and minorities were intentionally over-represented in the sample. All participants scored 650 or higher on the mathematics portion of the SAT. The seven universities were chosen to represent a cross section of the types of universities teaching future mathematicians, scientists and engineers. Four public and three private universities were included, varying in size and in the nature of their students. (Seymour & Hewitt, pp. 25 - 27) Again, the purpose of the study was to determine why S.M.E students change majors at higher rates than undergraduates in most other disciplines. In making this determination, Seymour & Hewitt describe the culture of the typical college science classroom and also factors counter to that culture that seem to encourage students to stay in the S.M.E pipeline.

I was only able to find one large-scale study that looked at the culture of teacher education classrooms -- the Salish I Research Project. The Salish Project was an exploratory study involving nine universities and their recent graduates in secondary science. Here, the project goal was to explore the nature of the links between teacher education programs, the way new science teachers teach and the outcomes of their students. This involved both teacher candidates and college faculty in both science and teacher education describing the coursework in their programs. An underlying assumption of the study was that both science and education faculty are teacher educators. Like Seymour and Hewitt's work, this study described the culture of the college science classroom. It also described the culture of the teacher education classroom. I have worked on the Salish I Project for the past two and a half years. The Executive Summary of the Salish Final Report, *Secondary Science and Mathematics Teacher Preparation Programs: Influences on New Teachers and Their Students,* is on the World Wide Web at <http://ed-web3.educ.msu.edu/cvsme/Salish.htm>.

In the Salish I Project all participants were volunteers. What might that mean? It seems reasonable to assume that volunteers for such a study would be more aligned with the culture of teaching. The culture of science is not known for its respect of either qualitative or educational research. If new teachers (NTs) subscribe to the culture of science, they may wish to have no part of such a project. Certainly, by using volunteer subjects, the data do not reflect the total population of new science teachers in every aspect. I know, from experience as a research associate for the project, that those who dropped out of the study (at least at MSU) were less likely to have valued their teacher education coursework. This is important to keep in mind as the reader evaluates the conclusions drawn in this paper.

Describing the Two Cultures:

Both *Talking About Leaving,* and The Salish Project describe striking similarities in the teaching of science and the broader culture of college science programs across the universities in their respective samples. In college science classrooms, it is common place that students are lectured to, competition is fostered and collaboration is discouraged. Little support from faculty is available or encouraged. (Seymour & Hewitt, 1997, Duggan-Haas, 1997). In teacher education, according to Salish findings, instructors generally attempt to foster a classroom community by requiring collaboration and discouraging competition. Students work in groups and are supported affectively by their professors.

[1] Some universities also included recent graduates in mathematics education.

(Duggan-Haas, 1997; Salish, 1997) The dichotomy is very real here and those who are familiar with both cultures instantly recognize the contrast.

New Teacher Perceptions of Classroom Culture		
Characteristic	**Science**	**Teacher Education**
Program purpose/goals	Goals are well-defined and understood: the goal of the typical course is to learn content; to learn facts	Goals are poorly defined or understood. Many different goals are identified.
Course Instruction	Lecture, "...mostly lecture. Not much labs, not great labs when we had them."	Group work/discussion, "I would say a little bit of everything besides lecture."
use of lecture	embrace	shun
use of cooperative learning	shun	embrace
class-size	large	small
textbook use	embrace	shun
Instructional Resources	Textbook	Readings — collections of articles
Methods of assessment	objective tests, mostly multiple-choice	written work before the internship, written work along with teaching performance during the internship.
Teacher-Student relationships	"By far, the commonest words used to describe encounters with S.M.E. faculty are 'unapproachable,' 'cold,' unavailable,' 'aloof,' indifferent,' and 'intimidating.'" (Seymour & Hewitt, p. 141)	personal; "Excellent," was a term used by half the Salish participants to describe the faculty-student relationship.
Program components valued by new teachers	Research or research like experiences – two new teachers graduated from MSU reported such experiences; one as a volunteer, the other at a different institution. In most cases, these experiences were outside the formal program for Salish participants.	The full-year internship; the sequence of courses in teacher education (TE) related to their subject matter. In all cases, these experiences were part of the formal program.
Partial Summary		
Classroom culture's relation to professional work	Undergraduate science courses do not generally reflect the work of scientists. However, they may reflect the work of science teachers as teachers frequently teach in the way they were taught.	Undergraduate teacher education courses reflect what teachers should do (in the opinion of teacher education faculty) in their own classrooms.

Table 1. It is little surprise that students see little relationship between their science and TE course work. It seems that every instructional characteristic of one program is reversed in the other. Unless otherwise noted, quotations are taken from New Teacher Interviews of MSU graduates.

(Adapted from Duggan-Haas, 1997a)

Table 1 shows a comparison of science classroom culture and teacher education culture that was created primarily from Salish data. Its conclusion about the science

classroom culture are supported by Seymour & Hewitt. Table 1 is derived from NT responses to questions on the New Teacher Interview. Teachers were asked a series of nine questions about their college science courses and then asked a series of nine questions parallel in structure regarding their teacher education courses.

On at least some level, both cultures "work." While it is true that more S.M.E. majors change their major than in other fields (a little more than 50%), we do not have a shortage of mathematicians, engineers or scientists, regardless of what some report in the popular press. In fact, there is a surplus of the most qualified members of these professions. (Shamos, 1995, Seymour & Hewitt, 1997) Likewise, there is no real shortage of teachers. (Shamos, 1995) However, as Linda Darling-Hammond notes, too many -- about half -- of middle school and high school science and mathematics teachers do not have degrees in the subjects they teach. (Darling-Hammond, 1997) Of course, there have been volumes upon volumes written portraying the dire state of schools and teacher education in modern day America (see, for example, National Commission on Excellence in Education (1983), Lanier & Little (1986) or Hirsch (1996)). There have been some well thought out critical responses to these pieces (see, for example, Berliner & Biddle (1995) and Labaree, (1996)).

The problems that Seymour and Hewitt describe and on which I concur are not seen as problems by all who teach science at the college level. The consequences of fixing these "problems" are difficult to predict. This analysis will lead to some informed speculation in this regard, however. When viewed from a perspective that is built upon some knowledge of pedagogy, it is very difficult to classify the current state of affairs as the way it ought to be. Several studies of tertiary science instruction have found fault. Smaller class sizes, and higher faculty-student interaction (monitoring, advising, counseling, involvement in faculty research) are methods that have shown to improve teaching and increase retention rates of students in science. These studies include the Office of Technological Assessment. reports of 1988 and 1989 and Porter, 1990 (in Seymour & Hewitt, pp. 6 - 7, 1997).

The most common problems stated by S.M.E students in Seymour & Hewitt were:

- lack or loss of interest in the disciplines which comprise S.M.E. majors, which ranked first (43.2%) among the reasons for switching, and was mentioned as a concern by 59.6% of all switchers and by 35.5% of non-switchers
- a non-S.M.E. major is seen as offering a better education, or more interest, which ranked second (40.4%) among reasons for switching was mentioned as a concern by 58.5% of all switchers, and by 31.6% of non-switchers
- poor teaching by S.M.E. faculty which ranked third (36.1%) among the reasons for switching, was mentioned as a concern by 90.2% of all switchers, and by 73.7% of non-switchers

(Seymour & Hewitt, p. 145)

As reflected above, problems that motivated switching were generally also recognized by students who did not switch majors. Seymour & Hewitt refer to this as the "problem iceberg." The problem is shown in students leaving S.M.E majors, but it lurks under the surface for those who remain. Notice the near unanimous concern about poor teaching among the switchers and non-switchers alike. It seems likely that these are not separate problems, but rather tightly intertwined. Poor teaching is perhaps a cause of both the lack of interest identified as the most common cause and clearly related to the second most common cause - better education available in non-S.M.E. majors. These problems of pedagogy are an integral part of "weeding out" students.

THE CONTRASTS:

① "Weeding out" vs. Nurturing all the flowers, weeds or not:

> "They do the usual speech: 'Look to the right of you; look to the left of you. Forty percent of you won't be here next year.' I think that's the standard speech at every university." (Male Black engineering non-switcher)
>
> (Seymour & Hewitt, p. 123)

As we go about cultivating future science teachers, we begin by planting them amidst students with a wide variety of career goals. In their introductory science classes, they sit among others who wish to become doctors, engineers, scientists and more. Indeed, many who become teachers begin with college with other career aspirations.[2] Immediately, the science department or college structure begins to "weed out" large numbers of these scientifically inclined undergraduates.

The phrase, "weed out" is common place in the vernacular of college and university S.M.E. students throughout the U.S. It is, however, a poorly chosen term for the process it describes. Weeding is selective. Weeds are removed from gardens because they do not hold the same promise for production as the plants which were intentionally planted. In, *Talking About Leaving: Why Undergraduates Leave the Sciences,* Seymour and Hewitt conclude that weeding out reduces numbers in the S.M.E garden, but it does so indiscriminately. The students who change majors, the "switchers," from S.M.E are just as likely to be qualified and successful in their coursework as those who stay in S.M.E. The quote at the beginning of this section is reflective of stories told on many campuses. It matches well with what I was told in my first undergraduate physics lecture. It does not encourage students in S.M.E.; it uniformly and indiscriminately discourages.

This traditional opening line of the first science lecture has multiple explanations. It communicates the common belief that a few individuals are, "born scientists." It contributes to the reduction in student numbers in the courses and programs which, on most campuses, could not be supported from freshman year through graduation if there was no attrition or minimal attrition. The speech reflects that the purpose of the course is not education, but rather selection (Seymour & Hewitt, p. 394). It begins the hazing portion of the indoctrination into the culture of science. It is, in effect, the signal that pledging the fraternity of science has begun. In some ways, this hazing is more cruel than fraternity hazing in that it not only demoralizes, it also denies mutual support.

For those who survive the hazing portion of the indoctrination, life gets better. In upper level courses, group work is often encouraged. The luckiest of students work on research projects with faculty. Those who complete research are far less likely to be switchers. And far more likely to like and respect science faculty (Duggan-Haas, 1997; Seymour & Hewitt 1997, p. 147). Hazing is discussed further in sections ② and ③.

In contrast, students in teacher education are nurtured. While many people believe there are natural born teachers, if teacher educators believe this it is not overt in their teaching. As a general rule, instructors in teacher education encourage, not discourage. Weeding out may occur (and perhaps should occur more) but it is not indiscriminate. People are not encouraged on the first day of course work to change their majors! Interview responses in the Salish Project indicate that students believe their professors in TE are approachable and those in science are unapproachable. (Again, see Table 1). Students are also encouraged to form support networks with their fellow students by working together on much of what they do in class and out.

This situation may be reversed in the world work. New teachers generally have the same responsibilities on the first day of school as veteran teachers, with little support in

[2] Again, I began college in an engineering program, for example.

handling those responsibilities. If the new graduate instead goes to work in industry, they are typically further trained and responsibilities are developed over time.

Selection is not a primary purpose of the coursework in TE. Coursework is intended to instruct, to educate, to prepare students for the world of work. Teacher education is vocational, unlike much of science and mathematics education.[3]

Poor teaching in science is rewarded on multiple levels. This is not to say, however, that science instructors intentionally (or universally) teach poorly. But it diminishes incentive to teach well. If a professor teaches poorly, fewer students will come to his or her course and more will drop the course, reducing the paperwork load. In the longer term, the loss of numbers in the program matches the structure of the program. If students did not drop out in large numbers, resources for upper level courses and labs would be overwhelmed. Poor teaching is also considerably easier than good teaching. Through student interviews, Seymour and Hewitt found that some science professors, on at least four of the seven campuses involved in their study, taught by reading directly from the text book as their primary method of instruction! (P. 154) This means that preparation for teaching is non-existent for these professors.

The harsh nature of curved grades also contributes to weeding out. It is not unusual for a 50% exam score to be a C or even a B after grades are curved. Receiving a 50% grade can be a severe ego shock to students who were often among the best in their high school class. The above raises several important questions. Is boring, uninspired teaching rewarded? Are poor assessments of understanding rewarded in ways not tied to their explicit purposes? Is the lack of teacher-student interaction rewarded by students dropping from science programs?

Seymour & Hewitt were unable to identify good indicators of what made one student more likely to switch out of S.M.E than another student. Switchers were about as likely to have good grades or poor grades as non-switchers. Switchers were more likely to be critical of their science teaching and less likely to have developed ways of coping with the stresses of their science coursework. One method of coping more common among non-switchers is collaborative group work in the form of study groups.

The above implies that the students who switch are just as capable of "doing science" as those who stay. It also implies that switchers are more concerned about quality teaching. Putting two and two together indicates that the process of weeding out discourages some of the best potential science teacher candidates from becoming teachers as an S.M.E. degree is generally required to teach science.

② *Meritocracy vs. Democracy:*

Though the weeding out process appears to be indiscriminate based on ability, this is not widely recognized within the college science classroom culture. An uncritical look at weeding out would lead to the conclusion that only the strong survive. It may be true that some of the strong survive, but some of the strong leave too. A more critical analysis might lead one to conclude that the brightest recognized a poor learning environment and intelligently sought a better education elsewhere. The culture of science is meritocratic in belief, but it is not so clear that it is meritocratic in practice.

Again, the process of weeding out is a hazing process. It forges a bond between those who survive it and it is their entrée into the culture. Weeding out serves to *indoctrinate* students into the culture of college science. It is far less clear that it helps to *educate* these same students about science. Hazing does not make one smarter or even more knowledgeable. Hazing induces a feeling of superiority. Ask any frat man which fraternity is the best on campus or any serviceman which branch of the armed forces is the best and you are most likely to hear that the organization to which he belongs is the best. Is

[3] I have intentionally omitted engineering here, as engineering students are more likely to be involved in vocational training including actual work in industry as part of their bachelor's degree program.

the primary purpose of the weed out courses is to educate science students or to select those who should continue? Both the means and ends in this process are suspect.

Students, switchers and non-switchers alike, complain of not understanding the material taught in the introductory courses. This material should be fundamental to understanding what happens in upper level courses. The true, deep understandings of the fundamental aspects of a science seem unlikely to be learned in the introductory courses. But surviving the weed out courses allows one to *feel* superior in intellect.

Weeding out is counter to much of what is taught in teacher education classes today. It is commonplace in teacher education to speak of educating *all children*. In fact, it is the foremost goal of *The National Science Education Standards* (NRC, 1996). If teacher educators weed out many students, they not only fail to model this core belief, but act in direct opposition to it. I have said that weeding out in science courses tends to be indiscriminate. This appears true based on ability, but it is not true based on gender or skin color. The culture of college science classrooms is dominated by white males. Weeding out disproportionately effects men of color and all women (Seymour & Hewitt, p. 132). Conversely, teaching has long been the professional work most open to men of color and especially to women.

The culture of the college science classroom is an elitist, market model while the culture of the college teacher education classroom is an egalitarian, democratic model. Teacher's colleges are the people's colleges. They are accessible to a large portion of the populace, and what is accessible is much more than entry into the programs. Successful completion of the programs is genuinely attainable. The same could hardly be said of science programs. While entry into S.M.E programs is achievable, exit from it with a degree only comes in a minority of cases.

Giving sharper, perhaps more legitimate, definition to the meritocracy of science are those individuals who seemed to intuitively grasp abstractions which other students could not seem to "get" no matter how much effort was put forth. These individuals were described on all seven of the campuses in Seymour & Hewitt's study, but they did not come close to dominating the non-switchers in numbers. They did serve to frustrate their fellow students by making the meritocratic nature of science painfully obvious, however. The existence of these curve-wrecking individuals goes counter to the democratic norms of education instilled in most students before arriving at college. Failure in grade school is seen not as a result of lack of ability but rather a lack of effort. This belief is carried on into college. (Seymour & Hewitt, pp. 101 - 102). And it is reinforced in colleges of education. After all, *all* children can learn (at least this is a dominant belief in those colleges of education)!

In the marketplace, grades in the two cultures have very different meanings. In the market driven, competitive world of science, grades matter. Grades are a commodity that buy admission to grad school. Good grades may be awarded with future scholarships (this is true in teacher education, too but to a much lesser degree). In teacher education, on the other hand, it is common for students to be told that grades do not matter. And it's true, at least to some degree. The more valuable commodity in the education marketplace is the letter of recommendation. Without good letters of recommendation from collaborating teachers and field instructors, starting teachers are at tremendous disadvantage in their job searches, even if their grades are outstanding.

The valued letters follow the trend of teacher education where assessment is generally far more qualitative throughout the program when compared to the science program. In the heated competition of science coursework conversely, the curve is king. The curve must be beaten to stay in the game. Beating the curve may mean breaking 55% on an examination (and the examination is likely to be objective and probably multiple choice). It means being driven to do better than your classmates. Adjusting to percentage scores in the range associated with curved exams is often difficult for students to do. The need to do better than average is also often a difficult adjustment. The idea that

collaboration is cheating is also a difficult shift in mindset from high school where cooperative learning is becoming more and more commonplace.

The competitive nature of science classes is illuminated well and some potential consequences are hinted at in the following quote from a male Hispanic engineering switcher:

> "The first two years here, all you think about is hoping you do better than everybody else -- actually, you hope that everybody else fails... It's bad. It breeds competitiveness and singles out certain kinds of people to succeed, as opposed to other more gentle types of people -- *people* people.
>
> (Seymour & Hewitt, p. 120)

Again, we see that the requirements of science programs that derive from the competitive culture may be chasing away some of the best science teacher candidates. The characteristics of assessment in science -- that it is individualistic and highly competitive -- are starkly different from assessment in teacher education. In teacher education, group projects are common. Assessed activities are generally term papers and written projects. Rarely are they objective tests (Salish, 1997). Collaborative group work is not only encouraged, but it is often an integral part of in-class work and not unusual for homework assignments. Curving grades is non-existent or virtually non-existent.

The culture of college science classrooms encourages the solitary endeavor and you must be strong, perhaps even manly, to carry out the endeavor. Science is seen as hard and only those with great ability, with merit, can be successful. Teacher education courses, on the other hand, are rarely seen as difficult, at least by those outside the culture. The collaborative work going on within them reflects a belief that we're all in this together. George Bernard Shaw's oft repeated words, "He who can, does. He who cannot, teaches," (Andrews, 1993) reflect the perception of teaching held by many. *Anyone* can teach. Teaching is commonplace. Science is prestigious. Even within education, teaching is often degraded, and degraded for not being scientific enough. See the scientistic teacher bashing of Lanier and Little, for example (1986).

Not surprisingly, teaching as a career choice is frowned upon within the culture of science. Many of the non-switchers in Seymour & Hewitt's study who planned to teach kept it from their science professors because of widely held beliefs that professors defined such ambition as deviant from the culture and that science professors withdraw from students who openly express an interest in teaching (p. 200). Disapproval comes not only from professors, but also from peers and parents. Detractors note that teaching requires additional preparation to make less money and have less prestige.

Students of color were the only S.M.E seniors who reported encouragement from science faculty or professional advisors to teach (p. 201). The most cynical part of me sees this as subtle racism -- preserving the white male domain of real science by shooing those perceived as "undesirables" into the lesser field of teaching. More optimistically, I am hopeful that it is the result of a recognized need for more positive minority role models in contact with children.

Twenty percent of the 335 students in Seymour & Hewitt's sample considered teaching as a career. Eight percent were actively pursuing teaching credential or planned to do so. The stamina of this eight percent is impressive in the face of the opposition of their science professors. Of course, they have been made stronger by surviving the hazing process. How many more would be pursuing teaching careers if it were not for the opposition of these professors?

Some of the twenty percent may eventually find their way into classrooms as teachers and others may develop an interest in teaching after working in industry. If they enter teaching through the back door, through alternative certification programs, they may embrace the teaching model for science that they know best, their college science coursework. Salish data indicates that when alternative programs offer support to teachers

only after they are placed in the field as employed teachers, the teachers tend to teach didactically. Seymour & Hewitt indicate that teachers in alternative programs without support often have severe problems with classroom management and often do not last long in the classroom.

The future workplaces of S.M.E. majors, for both teachers and non-teachers alike, stands in interesting contrast to the cultures of their college classrooms. Scientists, mathematicians and engineers, when they reach the world of work, are likely to move from the competitive, solitary work of their undergraduate experience to working on design or research teams. They are now placed in situations where they are rewarded for collaborating when they were punished for doing so as undergraduates. The teams they form, of course, may be highly competitive with other teams, but in order to be successful, they need to collaborate well together within each team. And teachers? Teachers go from collaborating with their classmates to the solitary life of a teacher, functioning as the sole adult, the sole professional, behind the door of their classroom. Hopefully, they facilitate the collaboration of their own students, but it is fairly unlikely that they work with other adults in teams the way their counterparts in the "real world" of science, engineering and mathematics. Some middle school teachers, fortunately, do work in meaningful teams. Unfortunately, some work in teams that are teams in name only.

③ Male vs. Female:

From the preceding contrasts, it is not hard to see that the culture of the college science can be described as a male culture while the culture of the teacher education classroom can be described as female. It is not terribly shocking, either. It is not unusual for students to complete a science or engineering degree program without having contact with a single female professor in their program. Teacher education was among the earliest departments to have female faculty and science (other than biology) is among the last. Science is a fraternity with hazing -- the weeding out process -- that at first glance appears to be discriminatory based on ability to *do* science. S.M.E. majors are more likely to change their major than majors in other fields, but women and people of color who are S.M.E. majors are even more likely to change their major than are white males.

Like in the broader culture of science, one viewpoint is recognized as being the correct one in culture of the college science classroom (Harding, 1991). The objective tests are perhaps the most powerful indicator of this. In teaching, however, multiple perspectives are acceptable, even desirable. Nurturing, mutual support and collaboration are valued, not individualism and competition. The profession of teaching was the first to be feminized -- over a hundred years ago. It is also the first profession to include people of color on a large scale. Teaching is inclusive while science is exclusive.

The culture of college science is often hostile to the culture of teacher education while the culture of teacher education is often envious of the culture of science. This hostility is shown by the active dissuasion by science faculty of their students away from teaching, as Seymour and Hewitt describe. The envy is evident in writing like that of Lanier and Little (1986). Science teaching has been seen as a craft, not a science. This contributes to its "female" quality. Efforts to make it more scientific, especially at the elementary level have been met with great opposition.

This section is the shortest of the three, but only because it synthesizes what precedes it. To repeat the above within this context is unnecessary. The rift between the cultures is deep, wide, and independent of the taxonomy used for classification for all intents and purposes.

Risk and Ambiguity

When NTs were asked in the Salish New Teacher Interview to describe course objectives those in TE were described and classified using an entirely different vocabulary from the objectives described for science courses. While there were six overarching

categories of responses about objectives in science, there were 16 in TE (see Table 2). This is not a result of using a finer tooth comb to sift through the TE objectives. The responses in regards to TE objectives were far more diverse. When NTs were asked about the objectives of their science classes, the majority included factual knowledge and almost half included lab skills. Other objectives were not stated at nearly these percentages. For TE, no response code received as much as 25%. The objectives in TE are less defined to the NTs. I interviewed ten of these individuals and they often were at a loss as to stating objectives for TE, but they had no real problem identifying objectives for their science courses. This difference, again speaks to the existence of two cultures. In science courses, the objective are clearly recognizable. In TE, they are muddled by their numbers. It is impossible to focus on a dozen (or dozens of) targets simultaneously.

Table 2 is based on responses in the New Teacher Interview to the following questions, "How would you describe your typical science course?" and, "How would you describe your typical teacher education course?" For both questions, interviewers were expected to probe for, "types of objective, e.g., certain knowledge, specific skills, attitudes towards science." For the question relating to teacher education courses, the probe was also to include attitude toward teaching secondary school students (Salish, 1997b). The sample consists of 70 NTs from eight universities (one site lost its tapes and transcripts).

Some of the goals of teacher education courses described by the NTs could be categorized as factual content knowledge (e.g., human development or psychology of teaching and learning) or skills (e.g., classroom management), however, there is more interdependency among the goals stated in teacher education. Many of the goals identified for TE can be described as developing certain attitudes (e.g., those addressing teaching as a profession). This was not the case for science classes. NTs tended to identify more than one goal for both sets of courses.

The learning goals of science courses are both clear and rigorous. In TE, the goals appear to be neither clear nor rigorous. While it seems clear that rigor is a virtue, it is less clear that clarity of objectives is a virtue. The NTs who could not readily identify the objectives of their TE courses did not seem proud of this ambiguity in their preparation. However, Walter Doyle (1986) makes a persuasive argument that workable solutions in the professional workplace are rarely unambiguous and that it is problematic that professional preparation (i.e. college coursework) is unambiguous. Doyle argues that rigorous courses tend to focus on memorization and not understanding - they are high risk with low ambiguity, while less challenging courses often focus on opinion rather than understanding. Neither portion of the program, science or TE, seems to be likely to bring about understanding, but for quite different reasons. Science courses seem to fit Doyle's model of courses that are unambiguous and challenging, while TE courses are more likely to be ambiguous and easy.

These different approaches might seem to be complementary - one section of the science teachers preparation is challenging and unambiguous and the other is ambiguous and unchallenging. This mixture does not, however, make for professional preparation that appropriately balances risk and ambiguity. That balance needs to occur within each class, not among several of them.

Through these differences in risk and ambiguity, these two portions of teacher education programs certify unprepared individuals. The science portion of the program is recognized as selective based upon ability, but Seymour and Hewitt demonstrate that may not be so. The education portion has long been recognized as being too inclusive and non-discriminatory based on ability.

Goals for science courses	% responding	Goals for Teacher Education Courses	% responding
1. Content Knowledge		**1. Teacher as researcher**	1
factual	72	**2. Teacher as reflective practitioner**	3
conceptual	19	**3. Teaching as a profession**	19
application	22	by sharing teaching experience	7
other	7	by discussing content relevant to teaching	29
2. Skills		professional organizations	0
laboratory	49	professional issues	3
algorithm & formula use	0	other	0
problem solving	12	**4. Human development**	1
other	4	**5. Psychology of teaching and learning**	7
3. Nature of Science	1	**6. Testing, measurement, evaluation and assessment**	6
4. Science, Technology & Society	3	**7. Philosophy of teaching**	
5. Interest/prepare students		develop research-based rationale	14
for upper courses	0	understand various models of teaching	10
for graduate school	13	constructivist philosophy	13
other	12	other	7
6. Enjoyment of science	16	**8. Management of learning environments**	
7. Other	6	where secondary students are active learners	26
		classroom management and discipline issues	21
		other	3
		9. Instructional design	23
		10. Nature of science	3
		11. Instructional technology	4
		12. Managing instructional resources	19
		13. STS	1
		14. Social foundations of education	1
		15. Development of writing skills	0
		16. Process skills of science	3
		17. Other	30

Table 2. Goals of Courses Identified by New Teachers. Totals are well in access of 100% as most NTs identified more than one goal, particularly in teacher education courses. Statistical tests were not completed as Salish participants were volunteers and therefore the sample is not random.

Conclusion

The distinction between the culture of college science and the culture of teacher education is not a false dichotomy. The differences are very real and have very real consequences. These cultures are not simply different from one another, but also in opposition to one another. They are cultures at odds. The exact nature of the consequences of the dichotomy in which science teacher candidates are prepared for teaching is difficult to measure, but not difficult to deduce.

Science teacher candidates are integral players in both cultures, yet we in teacher education do little to address the dichotomy. Our students move between these cultures in conflict with little help from teacher education and often with active opposition from science faculty. Failure to address the difference almost certainly allows promising science teacher candidates to seek and find other careers and shapes the teaching of candidates who complete the credentialing process in ways counter to what is best for their future students.

At Michigan State University, we may be addressing the conflict. The recently formed Division of Science and Mathematics Education cuts across the College of Education and the College of Natural Sciences. Some faculty members have dual appointments in the two colleges. The Collaborative Vision for Science and Mathematics Education is a newly formed group of faculty from the two colleges with a goal of improving communication and collaboration between interested faculty in the two colleges. In May of 1997, MSU hosted *Revitalizing Undergraduate Science and Mathematics Teaching,* a national conference with representatives from over 80 universities in attendance. This conference was supported with $100,000 from the provost's office and there will be a regional follow up conference June 2 through 4 of 1998 with funding from NSF. These organizational structures make MSU fairly unique. See Table 3 for relevant websites.

Organizational Structures Addressing the Gap Between the Two Cultures at Michigan State University	
The Collaborative Vision for Science and Mathematics Education	http://ed-web3.educ.msu.edu/cvsme/
Revitalizing Undergraduate Science and Mathematics Teaching: A National Dialogue, May 8-10, 1997	HTTP://www.ns.msu.edu/Conference.html
Great Lakes Region Shaping the Future Workshop - Teaching, Learning and Assessment in Undergraduate Science, Mathematics & Engineering, June 2 - 4, 1998	http://www.ns.msu.edu/announce.htm
The Division of Science and Mathematics Education	http://www.dsme.msu.edu/
The NOVA Project at MSU	http://ed-web3.educ.msu.edu/cvsme/nova.htm

Table 3 Websites of organizational structures that address the gap between the Two Cultures at Michigan State University. The author's website <http://www.msu.edu/~haasdona/> also has related links.

The two cultures can learn from each other, but not until they want to. It appears there is some interest here. Seymour & Hewitt conclude that the area in greatest need of reform [to reduce attrition from S.M.E. programs] is college science teaching, not curriculum, the most common target of reform. I agree. The following are suggested pre-requisites to improving college teaching.

What we need to do:

1. Pay attention to the difference in cultures! This step is listed first not because it is most important, but rather because it is simplest and it is a

prerequisite to other changes. This important step could be completely contained within colleges of education. Ideally, faculty in S.M.E. would pay attention in ways that lead to the second step.

2. Recognize that all science teachers are educated by university faculty and that scientists are, therefore, teacher educators. If they believe that new science teachers are ill prepared, they must share some of the blame and they must be responsible for helping to improve the situation.
3. Stop discouraging interested S.M.E. majors from pre-college teaching and start encouraging them into the world of teaching. Again, this is a logical pre-requisite to what follows and is technologically simple. It also would bring along with it a recognition that teaching is worthwhile.
4. Improve the sharing of understanding within teacher education and between teacher education and science faculty. Teacher education could learn from science about the sharing and development of ideas about teaching. Both science and teaching are processes that have developed substantial and interconnected bodies of knowledge. The culture of science does a far better job of sharing this knowledge with people within the culture than does the culture of teaching.
5. Improve college science teaching. This is clearly the most difficult as well as the most pressing of the tasks. It is unlikely that teaching will improve until it is more widely recognized as a problem. We must begin by making the goal of college science teaching education, not selection. Improving assessment in college science courses is a big part of improving teaching and learning.

What would be the consequences of improved college science teaching?

Not only will improving college science teaching reduce attrition in science programs, but it has great potential for improving the quality of pre-college science teaching. If college science teaching was improved substantially, students would not change their majors due to disappointment with teaching. They would be less likely to lose interest in science. Remember, the three most important factors in the decision to change majors are loss of interest in science, better educational opportunities exist in other disciplines and poor teaching in science classes (see page 4.) Precollege teachers would also *understand* science. Currently, they know a lot (that is, they have factual knowledge) but understand little (that is, they have little conceptual knowledge and are even weaker in process knowledge). (Gallagher, 1993)

Currently, the keepers of the culture of college science classrooms not only disparage teacher education and actively and effectively discourage their best students from pre-college teaching, they also disparage the pre-college preparation of their students. In other words, professors of science criticize pre-college science teaching and actively oppose its improvement by preventing the best students from pursuing a career in teaching! If science professors became more interested in improving their own teaching, it follows that they would be interested in promoting good teaching and in respecting the profession more broadly. Again, college science professors must recognize and address their role in the problem.

Improving college science teaching would bring need for other changes within programs. The nature of these changes is far beyond the scope of this paper, however I can briefly comment on the implications. Admission to programs would need to be more selective or the resources for upper level courses would be overwhelmed and the surplus of scientists and mathematicians would increase. Some of this surplus, however, would be redirected to the classroom. The problems oft cited by Darling-Hammond and many others (National Commission on Teaching & America's Future, 1996) of under-qualified and unqualified science and mathematics teacher would gradually diminish.

Consequences of the rift between the two cultures:

What if things are left as they are? What are the consequences of the existence of two classroom cultures in which our science teacher candidates develop into licensed teachers? The process of weeding out may discourage some of the best potential science teacher candidates from becoming teachers as an S.M.E. degree is generally required to teach science. Boring, uninspired teaching with poor assessments and no student-teacher interaction may be rewarded in the culture of the college science classroom! Weeding out serves to *indoctrinate* students into the culture of college science. It is far less clear that it helps to *educate* these same students about science. Those who survive the weed out process too often have poor pedagogical models for teaching science. Those who are interested in good teaching are more likely to leave the science degree programs than those who are not critical of teaching. This is likely to leave teacher candidates who are disinterested in the aspects of good teaching.

References:

Andrews, R., Editor (1993), *The Columbia Dictionary of Quotations.* Columbia University Press: New York.

Berliner, D. & Biddle, B, (1995), *The Manufactured Crisis: Myths Fraud and the Attack on America's Public Schools.* Addison Wesley: Reading, MA.

Darling-Hammond, L. (1997), "Teaching For The 21st Century", The Institute For Research On Teaching And Learning Colloquium, April 1997, East Lansing, MI

Doyle, W. (1986) "Academic Work" in *Academic work and educational excellence: Raising student productivity* , T. M. Tomlison & J. J. Walber, Eds., McCutchan: Berkley, CA

Duggan-Haas, D., (1997a) "Effects of Scientific Research and of Two Classroom Cultures in Science Teacher Preparation Programs," Paper presented at the National Association for Research in Science Teaching annual meeting, Oakbrook, IL.

Duggan-Haas, D., (1997b) "Defining STAM categories," internal memo, Michigan State University.

Gallagher, J. (1993)

Hirsch, E.D. Jr., (1996)*The Schools We Need & Why We Don't Have Them.* New York: Doubleday.

Labaree, David F. (1996). The trouble with ed schools. Educational Foundations, 10:3, 1-19.

Lanier, J. & Little, J. (1986) "Research on Teacher Education" in *Handbook of Research on Teaching, Third Edition.* New York: Macmillan

National Commission on Excellence in Education (1983), *A Nation at Risk: The imperative for educational reform.* Washington, DC: U.S. Department of Education

National Commission on Teaching & America's Future (1996), *What Matters Most: Teaching for America's Future.* Report of the National Commission on Teaching & America's Future, Summary Report. New York.

National Research Council (1996), *National Science Education Standards.* National Academy Press, Washington, DC.

Office of Technology Assessment. (1988). *Educating Scientists and Engineers: Grade School to Grad School.* Washington, DC: G.P.O.

Office of Technology Assessment. (1989). *Higher Education for Science and Engineering: A Background Paper.* Washington, DC: G.P.O.

Porter, O. (1990). *Undergraduate Completion and Persistence at Four Year Colleges and Universities: Completers, Persisters, Stop-outs, and Drop-outs.* Washington, DC: National Institute of Independent Colleges and Universities.

Salish, (1997a) *Secondary Science and Mathematics Teacher Preparation Programs: Influences on New Teachers and Their Students.* The University of Iowa.

Salish, (1997b) *Salish Instrument Package and User's Guide.* The University of Iowa.

Shamos, M., (1995) *The Myth of Scientific Literacy.* Rutgers University Press, New Brunswick, NJ.

Snow, C. P., (1959) *The Two Cultures and the Scientific Revolution.* Cambridge University Press, London.

Seymour, E. & Hewitt, N., (1997) *Talking About Leaving: Why Undergraduates Leave the Sciences.* Westview Press, Boulder, CO.

SE061299

ERIC®

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Two Programs, Two Cultures: The Dichotomy of Science Teacher Preparation

Author(s): Don Duggan-Haas

Corporate Source:

Publication Date: April 1998

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1	Level 2A	Level 2B
☒	☐	☐
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here,→ please

Signature: Don Duggan-Haas	Printed Name/Position/Title: Don Duggan-Haas	
Organization/Address: 301D Erickson Hall, Michigan State University East Lansing, MI 48824	Telephone: (517) 355-1725	FAX:
	E-Mail Address: haasdona@pilot.msu.edu	Date: 4/14/98

Share Your Ideas With Colleagues Around the World

Submit your conference papers or other documents to the world's largest education-related database, and let ERIC work for you.

The Educational Resources Information Center (ERIC) is an international resource funded by the U.S. Department of Education. The ERIC database contains over 850,000 records of conference papers, journal articles, books, reports, and non-print materials of interest to educators at all levels. Your manuscripts can be among those indexed and described in the database.

Why submit materials to ERIC?

- **Visibility.** Items included in the ERIC database are announced to educators around the world through over 2,000 organizations receiving the abstract journal, *Resources in Education* (*RIE*); through access to ERIC on CD-ROM at most academic libraries and many local libraries; and through online searches of the database via the Internet or through commercial vendors.

- **Dissemination.** If a reproduction release is provided to the ERIC system, documents included in the database are reproduced on microfiche and distributed to over 900 information centers worldwide. This allows users to preview materials on microfiche readers before purchasing paper copies or originals.

- **Retrievability.** This is probably the most important service ERIC can provide to authors in education. The bibliographic descriptions developed by the ERIC system are retrievable by electronic searching of the database. Thousands of users worldwide regularly search the ERIC database to find materials specifically suitable to a particular research agenda, topic, grade level, curriculum, or educational setting. Users who find materials by searching the ERIC database have particular needs and will likely consider obtaining and using items described in the output obtained from a structured search of the database.

- **Always "In Print."** ERIC maintains a master microfiche from which copies can be made on an "on-demand" basis. This means that documents archived by the ERIC system are constantly available and never go "out of print." Persons requesting material from the original source can always be referred to ERIC, relieving the original producer of an ongoing distribution burden when the stocks of printed copies are exhausted.

So, how do I submit materials?

- Complete and submit the *Reproduction Release* form printed on the reverse side of this page. You have two options when completing this form: If you wish to allow ERIC to make microfiche and paper copies of print materials, check the box on the left side of the page and provide the signature and contact information requested. If you want ERIC to provide only microfiche or digitized copies of print materials, check the box on the right side of the page and provide the requested signature and contact information. If you are submitting non-print items or wish ERIC to only describe and announce your materials, without providing reproductions of any type, please contact ERIC/CSMEE as indicated below and request the complete reproduction release form.

- Submit the completed release form along with two copies of the conference paper or other document being submitted. There must be a separate release form for each item submitted. Mail all materials to the attention of Niqui Beckrum at the address indicated.

For further information, contact...

Niqui Beckrum
Database Coordinator
ERIC/CSMEE
1929 Kenny Road
Columbus, OH 43210-1080

1-800-276-0462
(614) 292-6717
(614) 292-0263 (Fax)
ericse@osu.edu (e-mail)